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<i>DB=PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD; PLUR=YES; OP=OR</i>			
<input type="checkbox"/>	L13	l12 not l7 not l4	0
<input type="checkbox"/>	L12	L9 and (styrene)	4
<input type="checkbox"/>	L11	L9 and (styrene same acryl\$)	0
<input type="checkbox"/>	L10	L9 and(styrene same acryl\$)	0
<input type="checkbox"/>	L9	L8 and (gas adj black\$)	21
<input type="checkbox"/>	L8	zoch.in. or kalbitz.in. or ludtke.in. or tauber.in.	979
<input type="checkbox"/>	L7	L6 not l4	5
<input type="checkbox"/>	L6	(suspens\$ same (gas adj black)) and (styrene same acryl\$)	5
<input type="checkbox"/>	L5	(suspens\$ same (gas adj black))and (styrene same acryl\$)	5
<input type="checkbox"/>	L4	(suspens\$ same (gas adj black) same dbp)	4
<input type="checkbox"/>	L3	(suspens\$ same (gas adj black) same dbp) and (styrene same acryl\$)	0
<input type="checkbox"/>	L2	(suspens\$ same (gas adj black).same dbp) and (styrene same acryl\$ same copolymer\$)	0
<input type="checkbox"/>	L1	(suspens\$ same (gas adj black) same dbp) and (styrene same acryl\$ same copolymer\$) and neutraliz\$	0

END OF SEARCH HISTORY



255 Euclid Street, Akron, Ohio 44301-1921  
330-335-2100 • 800-321-2360 • FAX 330-535-8967

## CARBON BLACKS

### VULCAN<sup>®</sup>, REGAL<sup>®</sup>, STERLING<sup>®</sup>

#### DESCRIPTION:

Carbon Blacks are the most utilized fillers in the Rubber Industry. Based on its cost and performance, no other filler can match the properties of carbon black. Used for nearly 100 years, carbon blacks have been reinforcing rubber compounds both physically and chemically. Cabot Corporation has been producing carbon blacks for nearly 120 years and is now the world leader in the manufacturing of this essential ingredient. With production facilities in 18 countries on 5 continents, Cabot produces and develops carbon blacks for all rubber applications. Vulcan, Regal and Sterling blacks are standard furnace grades most commonly used in the industry. They vary in surface area (Iodine) and structure (DBP) so compounders are able to select the appropriate black, or combination of blacks, for their applications. The Vulcan blacks are considered reinforcing or hard blacks. These Sterling blacks are considered semi-reinforcing blacks. \* Regal 300 black is N326 reinforcing black.

#### REINFORCING:

Vulcan	9	10	10H	6	6LM	7H	300*	3	M	K
ASTM	N110	N120	N134	N220	N231	N234	N326	N330	N339	N351
Iodine	145	122	142	121	121	120	82	82	90	68
DBP	113	114	127	114	92	125	72	102	120	120

#### SEMI-REINFORCING:

Sterling	SO	VH	V	NS-1	NS
ASTM	N550	N650	N660	N762	N774
Iodine	43	36	36	28	29
DBP	121	122	90	64	72

Compounders chose carbon blacks basically by Iodine and DBP values. Iodine number represents the black's surface area. The higher the number, the more surface area is available to reinforce the rubber matrix. This affects failure properties like abrasion, tear, tensile strength, etc. The DBP number represents the structure (bulkiness) of the black. Again the higher DBP number equates to higher structure. This affects non-failure properties like modulus, die swell, loading capacity, conductivity and especially dispersion. For specialty cleaner (low impurities) blacks for improved: extrusion and injection molding, surface appearance, conductivity, dispersability, dynamic and flex properties, ECD (electrochemical degradation), etc. see additional Sterling, Spheron<sup>®</sup> and Conductive Carbon Blacks Technical Data Sheets.

<sup>®</sup> VULCAN, REGAL, SPHERON and STERLING are registered trade names of Cabot Corporation  
jh 0703, t-vulcan, regal, sterling

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# **CARBON BLACK**

## **(Group 2B)**

For definition of Groups, see Preamble Evaluation.

**VOL.** 65 (1996) (p. 149)

**CAS No.** 1333-86-4

### **Chem. Abstr. Names:**

- Carbon black, acetylene
- Carbon black, channel
- Carbon black, furnace
- Carbon black, lamp
- Carbon black, thermal

## **5. Summary of Data Reported and Evaluation**

### **5.1 Exposure data**

Carbon black is a powdered form of elemental carbon manufactured by the vapour-phase pyrolysis of hydrocarbon mixtures, such as heavy petroleum distillates and residual oils, coal-tar products, natural gas and acetylene. Worldwide production of carbon black in 1993 was approximately 6 million tonnes.

Carbon blacks are categorized as acetylene black, channel black, furnace black, lampblack or thermal black, according to the process by which they are manufactured. Lampblack is the oldest type of carbon black, having been used as a pigment for centuries. Channel black, produced from natural gas, was introduced in the late nineteenth century and was the major carbon black used worldwide in the early twentieth century for rubber and pigment applications; with the exception of a special product made in Germany, it is no longer produced. Acetylene, furnace and thermal blacks have been produced since the early twentieth century. Over 90% of all carbon black produced today is furnace black.

The primary use of carbon black is in rubber products, mainly tyres and other automotive products, but also in many other rubber products such as hoses, gaskets and coated fabrics. Much smaller amounts of carbon black are used in inks and paints, in plastics and in the manufacture of dry-cell batteries.

Types of carbon black are characterized by the size distribution of the primary particles, the degree of their aggregation and agglomeration and the various chemicals adsorbed onto the surfaces. Average primary particle diameters in several commercially produced carbon blacks range from 10 to 400 nm, while average aggregate diameters range from 100 to 800 nm. Typical classes of chemicals adsorbed onto the carbon black surface are polycyclic aromatic hydrocarbons (PAHs), nitro derivatives of PAHs and sulfur-containing PAHs. Examples of PAHs extracted most frequently from carbon black using a variety of extraction methods (e.g. prolonged Soxhlet extraction with benzene or toluene) include benzopyrenes, benzo[ghi]perylene, coronene, fluoranthene and pyrene.

Exposures to carbon black vary markedly within any production facility. The highest levels of exposure are experienced by those who interact with the process the most, including fitters/welders, warehouse packers and site cleaners. Exposures can vary greatly among factories and regionally.

Several studies in the 1960s found very high levels of exposure, even up to 1000 mg/m<sup>3</sup> in furnace, lamp- and channel black plants. Later studies in some countries have found lower levels, although many of these were in excess of the existant occupational exposure limits. In the late 1980s and early 1990s, more extensive studies in western Europe and the United States have found (geometric mean) personal exposure to total inhalable carbon black to be on average less than 1 mg/m<sup>3</sup>. Even lower exposures may occur among some workers in industries using carbon black, such as rubber, printing ink and paint manufacture, and exposures to carbon black in the use of rubber, printing ink or paint are negligible.

## 5.2 Human carcinogenicity data

The greatest potential for elucidating the carcinogenicity of carbon black is in the carbon black production industry where carbon black has been the prime industrial exposure and where exposure levels have been high. Cohort studies of carbon black production workers have been conducted in the United States and in the United Kingdom.

Interpretation of the study in the United States is hampered by problems of uncertainty in the completeness of the cohort and in the definition and completeness of follow-up. The study in the United Kingdom also had some problems in completeness of the cohort, but the follow-up was probably complete. In both cohorts, fewer observed than expected deaths due to all causes occurred and, in the study in the United States, this may in part have been attributable to underascertainment of deaths or to inflation of person-years of follow-up. The study in the United States found no excess mortality due to any type of cancer when compared to state vital statistics rates; in fact there were deficits for some types of cancer. The study in the United Kingdom found an excess of respiratory cancer deaths (standardized mortality ratio, 1.5; 95% confidence interval, 1.0-2.2).

A nested case-control study within the United States cohort was hampered by very small numbers and problems of interpretation. Most cases were of non-melanoma skin cancer. Neither for all cancers combined nor for skin cancers alone was there evidence that cases had higher cumulative exposure to carbon black than controls.

A cohort study was carried out among workers in the United States to assess cancer risks due to exposure to formaldehyde. Ten participating plants were spread across several industries in which workers may have experienced exposure to formaldehyde. To control for confounding and modification of effect by other exposures, workers' exposures to various other chemicals, including carbon black, were assessed by industrial hygienists. For all assessed levels and durations of exposure to carbon black combined, there was a slight nonsignificant excess of lung cancer. There was no clear trend by duration of exposure. Carbon black-exposed workers in this cohort may also have been exposed to formaldehyde and other substances.

Another industry-based study was a nested case-control study conducted in the tyre and rubber manufacturing industry to examine the association of squamous-cell carcinoma of the skin with rubber manufacturing materials. For each study subject, industrial hygienists assessed exposure to five substances, including carbon black, based on evaluations of each subject's job history. The results of this study indicated no effect of carbon black on skin cancer.

In a community-based case-control study in Canada, interviews were designed to obtain detailed lifetime job histories and information on potential confounders. Potential occupational exposures were identified for each job description, and among the exposures assessed was carbon black. In this study population, potential exposure to carbon black occurred in some individuals in user industries, notably among painters and in the printing and rubber industries. For the following cancer sites, there was no indication of excess risk in relation to carbon black: stomach, colon, rectum, pancreas, prostate, urinary bladder, skin melanoma and non-Hodgkin's lymphoma. For the following sites there was indication of excess risk: oesophagus, kidney and lung. The lung cancer excess was particularly concentrated among oat-cell cancers.

A Swedish case-control study reported a nonstatistically significantly increased risk for urothelial cancer for men exposed to carbon black.

In assessing all the available data, there is no evidence of an effect of carbon black for most cancer sites. For cancers of the urinary bladder, kidney and oesophagus, isolated results indicate excess risks, but these are not sufficient to support an evaluation of human carcinogenicity.

Two studies were informative for non-melanoma skin cancer (a nested case-control study among the United States carbon black production cohort and a nested case-control study among rubber workers); neither demonstrated any excess risk for skin cancer due to carbon black.

Of the studies listed above, four were considered informative for lung cancer. Of those, two indicated excess risk among carbon black-exposed workers at borderline statistical significance (the carbon black production cohort in the United Kingdom and the Canadian community-based study), one indicated excess risk but was not significant (the United States formaldehyde cohort) and the other indicated no excess (the United States carbon black production cohort).

Each of the available studies has limitations for the specific purpose of assessing the carcinogenicity of carbon black. The Working Group considered the study of carbon black producers in the United Kingdom to be the most informative for this purpose. That study indicated an excess risk of borderline significance. Confounding by smoking could not be excluded, although some information was presented indicating that it was unlikely. The formaldehyde cohort study indicated a slight excess of lung cancer among the subgroup exposed to carbon black, but this could easily have been due to chance or confounding by formaldehyde or other occupational substances. The community-based study in Montréal of exposure in a variety of user industries showed an elevated risk in the subgroup categorized as having high exposure to carbon black; the result was of borderline statistical significance using a cancer series control group and not significant using a population control group. It is not clear which control group provides the most valid estimates. Even the high-exposure subgroup of this study was unlikely to have experienced exposure levels of the same order of magnitude as did workers in the carbon black production industry. Although the United States carbon black worker study, which was negative, was large, its methodological limitations detracted from its value. The Working Group therefore considered the whole body of evidence rather weak and the results conflicting.

### 5.3 Animal carcinogenicity data

No adequate study of the carcinogenicity of carbon black administered by the oral route was available.

In one study in female mice by inhalation exposure, carbon black did not increase the incidence of respiratory tract tumours.

Two different carbon black products were tested in two inhalation studies in female rats and in one study using rats of each sex. Significant increases in the incidence of malignant lung tumours and the incidence of benign and malignant lung tumours combined were observed in female rats in all three studies. In addition, increased incidences of lesions described as benign cystic keratinizing squamous-cell tumours or squamous cysts were observed.

In two studies in female rats by intratracheal administration, using one type of carbon black, both extracted and non-extracted material increased the incidence of benign and malignant lung tumours. In one of the studies, a different type of extracted carbon black with a larger primary particle size increased the incidence of lesions described as benign cystic keratinizing squamous-cell tumours.

In several skin-painting studies in mice using various carbon blacks, no carcinogenic effect on the skin was observed; the painting of several carbon black extracts (benzene extracts) resulted in skin tumours.

In a series of studies in male and female mice by subcutaneous injection, a carbon black containing demonstrable quantities of carcinogenic PAHs produced local sarcomas, whereas a carbon black from which no PAH was detected did not produce such sarcomas. In several studies in mice, solvent extracts of carbon black produced sarcomas following subcutaneous injection.

### 5.4 Other relevant data

Upon inhalation exposure of humans to carbon black, these particles are deposited in the lung. The exposure may cause slight radiological changes. The prevalence of radiological findings has varied considerably among different studies, probably because of varying radiological techniques and possibly also due to different exposure circumstances and possible concomitant exposures to other compounds. Further, workers may develop chronic bronchitis and a slight reduction in lung function. These findings may be interpreted mainly as a slight nonspecific irritant effect of heavy dust exposure. On the other hand, some data indicate a fibrous tissue reaction in the area surrounding the carbon deposits in the lung parenchyma.

Studies on the pulmonary retention of inhaled carbon blacks in rats and mice have shown that these particles behave very similarly to other low-solubility, low-toxicity particles. Carbon black displayed normal retention characteristics in rats at lung burdens not exceeding a certain level which is approximately in the range of 0.5-1 mg/g of lung. At higher lung burdens, a prolonged clearance is found. Impaired particle clearance due to high loading of carbon black in experiments with rats results in increased accumulation of particles. Subsequent inflammatory responses occur which develop into chronic active inflammation. Increased collagen deposition from proliferating fibroblasts, increased epithelial cell proliferation and metaplasia have been found at high lung burdens of carbon black. It appears that the high specific surface area of most carbon blacks may be an important parameter in the induction of inflammatory and

subsequent other responses in the lung. One study with carbon black in rats confirmed findings with other particles that females are more sensitive than males.

Most assays for mutagenicity are negative for carbon black. In rats exposed to carbon black by inhalation, *hprt* mutant frequency was elevated in type II cells following a 12-week exposure. Carbon black did not induce a significant increase in DNA adducts in peripheral lung tissue of rats after two years of inhalation exposure. In another study, exposure of rats by inhalation to carbon black increased DNA adduct levels in type II cells. *K-ras* mutations were found in one out of 18 neoplasms analysed from a carbon black-exposed rat. No exposure-related *p53* mutation was found.

Some mechanistic considerations on particle-induced lung neoplasms are presented.

## 5.5 Evaluation

There is *inadequate evidence* in humans for the carcinogenicity of carbon black.

There is *sufficient evidence* in experimental animals for the carcinogenicity of carbon black.

There is *sufficient evidence* in experimental animals for the carcinogenicity of carbon black extracts.

## Overall evaluation

Carbon black is *possibly carcinogenic to humans (Group 2B)*.

For definition of the italicized terms, see Preamble Evaluation.

**Previous evaluation:** Suppl. 7 (1987) (p. 142)

## Synonyms:

### Synonyms for carbon black, acetylene

- Acetylene Black
- CI 77266
- CI Pigment Black 7
- Explosion acetylene black
- Explosion black
- P68
- P1250
- Shawinigan acetylene black
- Ucet

### Synonyms for carbon black, channel

- Aroflow
- Arrow
- Atlantic
- Black Pearls
- Carbolac
- Carbomet
- Channel black
- CI 77266
- CI Pigment Black 7
- CK3
- Collocarb
- Conductex, Continental

- Croflex
- Crolac
- Degussa
- Dixie
- Dixiecell
- Dixiedensed
- Elf
- Excelsior
- Farbruss
- Fecto
- Huber
- Impingement black
- Kosmink
- Kosmobil
- Kosmolak
- Kosmos
- Kosmover
- Micronex
- Mogul
- Monarch
- Neo-Spectra
- Peerless
- Printex
- Raven
- Regent
- Royal Spectra
- Special Black IV & V
- Spheron
- Superba
- Super-Carbovar
- Super-Spectra
- Texas
- Triangle
- United
- Witco
- Wyex

#### **Synonyms for carbon black, furnace**

- Aro
- Arogen
- Aromex
- Arotone
- Arovel
- Atlantic
- Black Pearls
- Carbodis
- CI 77266
- CI Pigment Black 7
- Collocarb
- Conductex, Continex
- Corax
- Croflex
- Dixie
- Durex
- Elftex
- Essex

- Furnace black
- Furnal
- Furnex
- Gas-furnace black
- Gastex
- Huber
- Humenegro
- Kosmos
- Metanex
- Modulex
- Mogul
- Molacco
- Monarch
- Neotex
- Oil-furnace black
- Opal
- Peerless
- Pelletex
- Philblack
- Printex
- Rebonex
- Regal
- Special Schwarz
- Statex
- Sterling
- Texas
- Ukarb
- United
- Vulcan

#### **Synonyms for carbon black, lamp**

- Carbon Black BV and V
- CI 77266
- CI Pigment Black 6
- Durex
- Eagle Germantown
- Flamruss
- Lamp black
- Magecol
- Tinolite
- Torch Brand

#### **Synonyms for carbon black, thermal**

- Atlantic
- Cancarb
- CI 77266
- CI Pigment Black 7
- Croflex
- Dixitherm
- Huber
- Kosmotherm
- Miike 20
- P-33
- Sevacarb
- Shell Carbon

- Statex
- Sterling
- Therma-atomic black
- Thermal black
- Thermatomic
- Thermax
- Thermblack
- Velvetex

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Last updated 08/14/1997

## **CARBON BLACK (Group 2B)**

For definition of Groups, see Preamble Evaluation.

**VOL.** : 65 (1996) (p. 149)

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In a series of studies in male and female mice by subcutaneous injection, a carbon black containing demonstrable quantities of carcinogenic PAHs produced local sarcomas, whereas a carbon black from which no PAH was detected did not produce such sarcomas. In several studies in mice, solvent extracts of carbon black produced sarcomas following subcutaneous injection.

### 5.4 Other relevant data

Upon inhalation exposure of humans to carbon black, these particles are deposited in the lung. The exposure may cause slight radiological changes. The prevalence of radiological findings has varied considerably among different studies, probably because of varying radiological techniques and possibly also due to different exposure circumstances and possible concomitant exposures to other compounds. Further, workers may develop chronic bronchitis and a slight reduction in lung function. These findings may be interpreted mainly as a slight nonspecific irritant effect of heavy dust exposure. On the other hand, some data indicate a fibrous tissue reaction in the area surrounding the carbon deposits in the lung parenchyma.

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Some mechanistic considerations on particle-induced lung neoplasms are presented.

## 5.5 Evaluation

There is *inadequate evidence* in humans for the carcinogenicity of carbon black.

There is *sufficient evidence* in experimental animals for the carcinogenicity of carbon black.

There is *sufficient evidence* in experimental animals for the carcinogenicity of carbon black extracts.

## Overall evaluation

Carbon black is *possibly carcinogenic to humans (Group 2B)*.

For definition of the italicized terms, see Preamble Evaluation.

**Previous evaluation:** Suppl. 7 (1987) (p. 142)

## Synonyms:

### Synonyms for carbon black, acetylene

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- CI 77266
- CI Pigment Black 7
- Explosion acetylene black
- Explosion black
- P68
- P1250
- Shawinigan acetylene black
- Ucet

### Synonyms for carbon black, channel

- Aroflow
- Arrow
- Atlantic
- Black Pearls
- Carbolac
- Carbomet
- Channel black
- CI 77266
- CI Pigment Black 7
- CK3
- Collocarb
- Conductex, Continental

- Croflex
- Crolac
- Degussa
- Dixie
- Dixiecell
- Dixiedensed
- Elf
- Excelsior
- Farbruss
- Fecto
- Huber
- Impingement black
- Kosmink
- Kosmobil
- Kosmolak
- Kosmos
- Kosmover
- Micronex
- Mogul
- Monarch
- Neo-Spectra
- Peerless
- Printex
- Raven
- Regent
- Royal Spectra
- Special Black IV & V
- Spheron
- Superba
- Super-Carbovar
- Super-Spectra
- Texas
- Triangle
- United
- Witco
- Wyex

#### **Synonyms for carbon black, furnace**

- Aro
- Arogen
- Aromex
- Arotone
- Arovel
- Atlantic
- Black Pearls
- Carbodis
- CI 77266
- CI Pigment Black 7
- Collocarb
- Conductex, Continex
- Corax
- Croflex
- Dixie
- Durex
- Elftex
- Essex

- Furnace black
- Furnal
- Furnex
- Gas-furnace black
- Gastex
- Huber
- Humenegro
- Kosmos
- Metanex
- Modulex
- Mogul
- Molacco
- Monarch
- Neotex
- Oil-furnace black
- Opal
- Peerless
- Pelletex
- Philblack
- Printex
- Rebonex
- Regal
- Special Schwarz
- Statex
- Sterling
- Texas
- Ukarb
- United
- Vulcan

#### **Synonyms for carbon black, lamp**

- Carbon Black BV and V
- CI 77266
- CI Pigment Black 6
- Durex
- Eagle Germantown
- Flamruss
- Lamp black
- Magecol
- Tinolite
- Torch Brand

#### **Synonyms for carbon black, thermal**

- Atlantic
- Cancarb
- CI 77266
- CI Pigment Black 7
- Croflex
- Dixitherm
- Huber
- Kosmotherm
- Miike 20
- P-33
- Sevacarb
- Shell Carbon

- Statex
- Sterling
- Therma-atomic black
- Thermal black
- Thermatomic
- Thermax
- Thermblack
- Velvetex

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